CHROMOSOME STUDIES OF PARNASSIA AND LEPUROPETALON (SAXIFRAGACEAE) FROM THE EASTERN UNITED STATES. A NEW BASE NUMBER FOR PARNASSIA

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Parnassia is a saxifragaceous genus of approximately 50 species of herbaceous perennials typically found in wet meadows and bogs. The genus ranges throughout the arctic and temperate regions of the northern hemisphere and was recently discussed by Spongberg (1972) as part of a generic flora of the southeastern United States. Spongberg summarized the troubled taxonomic history of *Parnassia,* a genus considered somewhat anomalous in the Saxifragaceae, but focused most of his discussion on the taxonomic position and interspecific relationships of four species which occur in the eastern United States. These species, *P. asarifolia, P. grandifolia, P. caroliniana,* and *P. glauca,* all belong to sect. *Parnassia* and, with the exception of *P. glauca,* they are all local or rare. Spongberg noted that considerable taxonomic confusion has resulted from the morphological similarities among *P. grandifolia, P. caroliniana,* and *P. glauca,* and he summarized the characters by which they can be distinguished. In addition, we have found in our material that *P. caroliniana* possesses a long creeping rhizome which contrasts sharply with the short erect rhizomes of *P. grandifolia* and *P. glauca.*

Spongberg reported that a chromosome base number of $x = 9$ characterizes *Parnassia,* but noted that none of the species of this eastern United States complex has been examined cytologically. A base number of $x = 8$ has been indicated by the reported count of $2n = 16$ for Himalayan *P. nubicola* of sect. *Nectarotribolos* as cited by Federov (1969). This anomalous base number led us to investigate the original source of the *P. nubicola* count, and this search has revealed several errors in the literature that we correct here in collaboration with Dr. J. L. Hamel.

The source of the reference to $2n = 16$ for *Parnassia nubicola* from Bhutan is a paper by Hamel (1953). Reference works by Chadefaud and Emberger (1960) and Federov (1969) in which numbers based on $x = 8$ are reported for *Parnassia* species have apparently taken their data from Hamel's table (1953, p. 266) in

which these numbers are simply typographical errors (Hamel, pers. comm.). Earlier in his paper (fig. 88 and pp. 225–228), Hamel clearly indicated that in *P. nubicola* $2n = 18$. He also correctly attributed counts based on $x = 9$ to the other *Parnassia* taxa which are erroneously recorded in his table as based on $x = 8$. Hamel (pers. comm.) shares our view that the counts of $2n = 20$ by Pace (1912; see also Hamel, 1953, p. 226) and by Tischler (1934) in *P. palustris* may actually be misinterpretations of $2n = 18$. Prior to our report, therefore, the only accurately recorded and undisputed base number in *Parnassia* is $x = 9$, with diploids, triploids, tetraploids, and hexaploids known.

Spongberg (1972) also discussed the monotypic genus *Lepuropetalon,* which is known disjunctively from the southeastern United States and Mexico, central Chile, and Uruguay and which is thought to be closely related to *Parnassia* on the basis of similarities in floral and tannin sac morphology. He suggested that a chromosome count from this cytologically unknown genus might further substantiate this relationship, as recent palynological data have done (Hideux & Ferguson, 1976).

In an effort to determine whether cytotaxonomic differences exist within this *Parnassia* complex and to provide new data pertaining to the putative relationship between *Parnassia* and *Lepuropetalon,* we have undertaken a cytological examination of these *Parnassia* species and *L. spathulatum*.

MATERIALS AND METHODS

Root tips for mitotic squashes were obtained from the following sources. Living plants of *Parnassia* species were collected in the field (Table 1) and subsequently cultured in the Indiana University greenhouses. Plants of *Lepuropetalon spathulatum* were grown from seed obtained from herbarium specimens (*Thomas 43386* & *43527* NLU; Table 1) and were cultured on a sand-soil mixture in the laboratory.

Mitotic squashes were based on the technique of Roy and Manton (1965) except that in view of the small size of the chromosomes, the paradichlorobenzene treatment was omitted and the snail cellulase ("glusulase") was obtained in prepared form from Endo Laboratories, Inc., Garden City, N. Y. Slides were made permanent in Permount following the method of Sears

(1941). A single chromosome squash is illustrated for each species, but at least three replicate counts of each have substantiated the illustrated numbers. Vouchers are cited in the captions of figures. Photographs for Figures 1, 5, and 9 utilized phase contrast optics; those for Figures 3 and 8 used bright field.

Table 1. **Collections Studied.**

Parnassia asarifolia Vent. **Virginia,** BLAND CO.: along both margins of Dismal Creek, 0.6 mi. NE of jct. of Appalachian Trail with Rte. 606, 0.1 mi. from Giles Co. line. *Soltis 971.*

Parnassia grandifolia DC. **North Carolina,** ASHE CO.: bog, bordering unmarked dirt road on E slope of Bluff Mt., ca. 2.5 mi. NW of Beaver Creek Church. *Soltis 970.*

Parnassia caroliniana Michx. **North Carolina,** LEE CO.: overgrown ditch near margin of wooded area along RR right-of-way, 0.3 mi. E of jct. of Rtes. 1176 & 1179. *Soltis 1008.*

Parnassia glauca Raf. **Indiana,** TIPPECANOE CO.: Flint Creek Hill Marsh, bordering Reserve Rd., 0.1 mi. from Fountain Co., 2.5 mi. W of West Point. *Soltis 969.*

Lepuropetalon spathulatum (Muhl.) Ell. **Louisiana,** BIENVILLE PARISH: under edge of building of Mt. Olive Baptist Church beside La. 147 jct. with La. 155, Sec. 32, T16N, R4W. *Thomas 43386* NLU. **Louisiana,** CADDO PARISH: cemetery and road bank of Fluornoy-Lucas Rd. at jct. with U.S. 171, Shreveport. *Thomas 43527* NLU.

RESULTS AND DISCUSSION

The mitotic chromosome squashes reported here (Figures 1–10) provide the first counts for *Parnassia asarifolia, P. grandifolia, P. caroliniana, P. glauca,* and *Lepuropetalon spathulatum.* The number for all four *Parnassia* species is $2n = 32$, whereas that for *L. spathulatum* is $2n = 46$.

Our counts of *Parnassia,* all based on $x = 8$, indicate that these species are tetraploid and establish a new base number for the genus. All previous known counts of *Parnassia* species have been summarized in Federov (1969). Several of these taxa have been

subsequently recounted, but without the addition of any new numbers (Ornduff, 1967, 1968; Moore, 1973). The counts of $2n = 16$ (*P. nubicola* and *P. palustris*) and $2n = 32$ (*P. obtusiflora*) given by Hamel (1953, p. 266) and repeated in part by Chadefaud and Emberger (1960) and Federov (1969) are erroneous, as discussed above. The cytological data presented here complement previous morphological data in delimiting these four eastern United States species of *Parnassia* as a natural group.

Our counts of $2n = 46$ for *Lepuropetalon spathulatum* provide the first chromosome data for this genus whose taxonomic history has been summarized by Spongberg (1972). Based on the data in Federov (1969), this number is uncommon in the Saxifragaceae, known only as part of the aneuploid series in *Saxifraga granulata* and *S. sp.* (*moschata* or *exarata*?). This high chromosome number does not readily support the putative relationship between *Lepuropetalon* and *Parnassia*. In fact, it does little to support the inclusion of *Lepuropetalon* in the Saxifragaceae. It could have been variously derived, for example via an aneuploid decrease from $2n = 48$. Only through such a hypothetical permutation would *Lepuropetalon* relate cytologically to *Parnassia* by sharing the herein established base number of $x = 8$. Counts of *Lepuropetalon* from its other disjunct stations may be instructive in this regard.

SUMMARY

A cytological study of four species of *Parnassia* from the eastern United States has firmly established a new base number ($x = 8$) for the genus and has corrected previous erroneous references to a base number of $x = 8$ for other species in the genus. *Lepuropetalon* has been considered closely related to *Parnassia* based on morphological similarities. New evidence from cytology presented here can be variously interpreted but does not readily support the proposed close affinity between the two genera.

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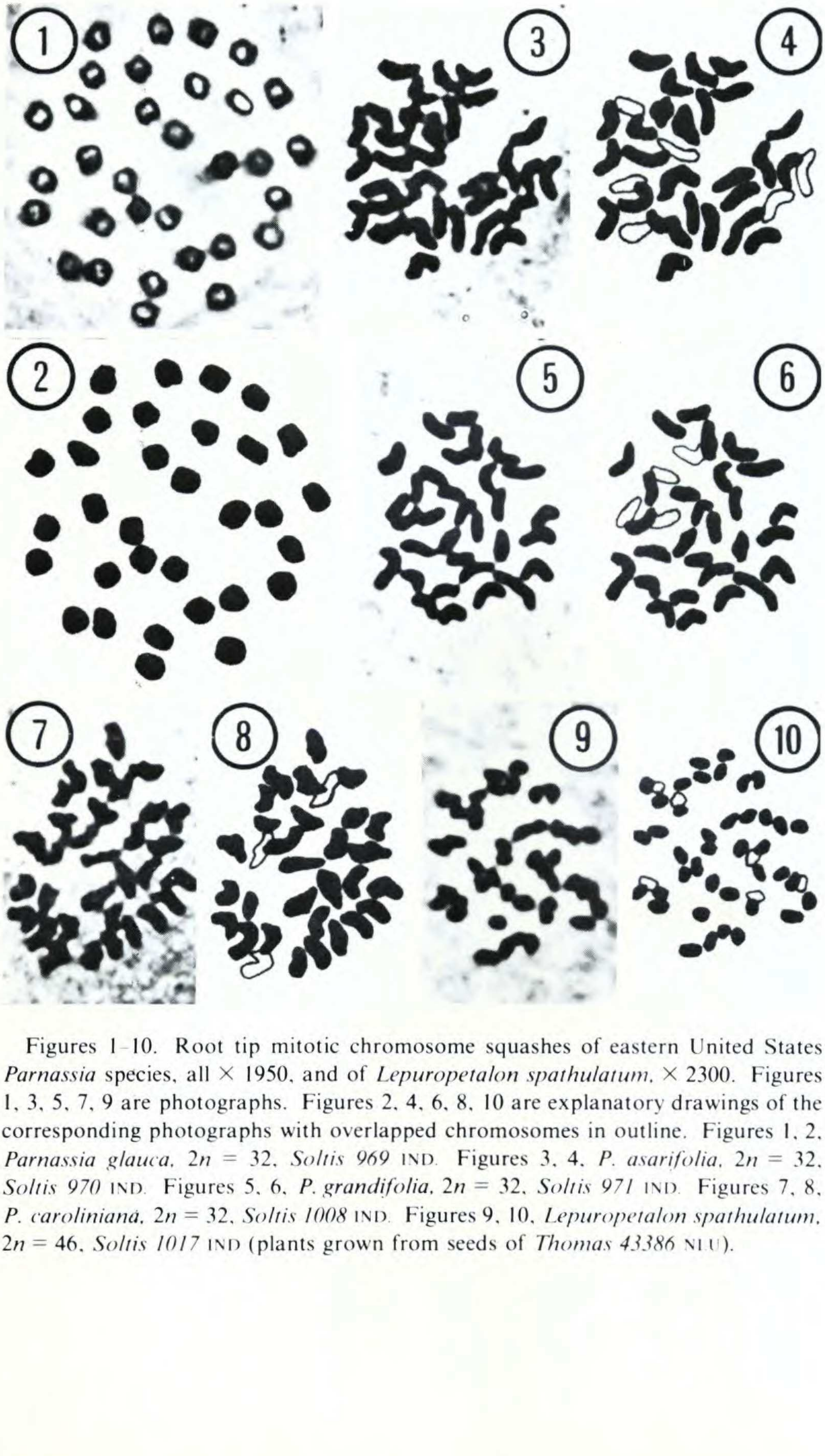

Figures 1–10. Root tip mitotic chromosome squashes of eastern United States *Parnassia* species, all × 1950, and of *Lepuropetalon spathulatum*, × 2300. Figures 1, 3, 5, 7, 9 are photographs. Figures 2, 4, 6, 8, 10 are explanatory drawings of the corresponding photographs with overlapped chromosomes in outline. Figures 1, 2, *Parnassia glauca*, $2n = 32$, *Soltis 969* IND. Figures 3, 4, *P. asarifolia*, $2n = 32$, *Soltis 970* IND. Figures 5, 6, *P. grandifolia*, $2n = 32$, *Soltis 971* IND. Figures 7, 8, *P. caroliniana*, $2n = 32$, *Soltis 1008* IND. Figures 9, 10, *Lepuropetalon spathulatum*, $2n = 46$, *Soltis 1017* IND (plants grown from seeds of *Thomas 43386* NLU).

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